Electron-Ion Collider
Record of Decision

TITLE	Modified LFHCal modules and structure
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NUMBER (Supplied by SEG)	EIC-ROD-028
DATE	06/18/2024
AFFECTED WBS/PROJECT AREA	WBS 6.10.06.03 Forward Hadron Calorimeter

STATEMENT OF DECISION (Summary, 1-2 sentences):

It was decided to only use steel absorber plates the in the LFHCal and insert modules and not use tungsten for the first seven layers. Space constraints for service lines require a reduction in total length by 8 cm (out of 140 cm). The cradle design is helped by a more symmetrical LFHCal layout in octagonal front face.

Description/Purpose:

In this document, we specify the choice of absorber material for the ePIC Forward Calorimeter, which is driven by the requirements of the EIC scientific program in conjunction with the comprehensive detector design and seamless integration. The (longitudinally segmented) forward hadronic calorimeter (FHCal) can be separated in two different regions, which are characterized by their different module construction techniques and read-out schemes: a) outer region with 8M and 4M modules (LFHCal) and b) the insert[1]. In addition to the physics requirements, the FHCal also provides part of the flux return for the solenoid magnetic field in the experiment. The original design of the FHCal included a combination of tungsten and magnetic steel layers to achieve both goals.

One recommendation from the Final Design Review was to use a simpler layout with only steel absorbers. After careful considerations and implementation of a significantly improved software compensation algorithm, which also takes into account the electromagnetic calorimeter material (EMCal) and response, it has been concluded, that the tungsten layers prove to be unnecessary in the full ePIC detector configuration [1]. With the tungsten used in the EMCal and the depth information available within the FHCal, the energy resolution of the hadronic calorimeter can be improved through a software compensation scheme. Using the most recent software compensation algorithm, an energy resolution for single pions of $\delta E/E = 27\%/\sqrt{E} \oplus 3\%$ can be

[1] Due to the different exposure to radiation in the two different areas the insert is designed such that the SiPMs, if necessary, can be removed and replaced without disassembly of the rest of the detector. This is not the case for the 8M and 4M modules after they have been assembled into full endcaps in the experimental hall.

achieved. This meets the requirements laid out in the Yellow Report [2]. The position resolution shows little to no worsening for single particle showers[2].

Furthermore, the impact of replacing the tungsten layers with magnetic steel has been evaluated with regards to the stray magnetic fields surrounding the beam pipe. It has been shown that the new configuration is preferable also in this respect.

Due to space constraints for service lines of the EMCal, it is required that the length of the LFHCal is reduced by 8 cm from the current total length of modules of 140 cm. The reduction of absorber layers from 65 to 60 is below 5% in the overall nuclear interaction length and does not significantly affect the performance of the combined EMCal & LFHCal energy measurement with the software compensation.

The cradle design is now in an advanced stage and it will be significantly simplified with a more symmetrical (octagonal) outline of the front face of the LFHCal. This means that some additional 8M and 4M modules should be added around the lower edges of the LFHCal. The SiPM's from the reduced length (see above) can be used without any additional cost to make these modules an active part of the detector.

References

[1] LFHCal consortium, LFHCal absorber material change (2024). URL https://indico.bnl.gov/event/22321/contributions/87717/attachments/53050/90727/LFHCAL TIC DSC 20240304.pdf

[2] Science Requirements and Detector Concepts for the Electron-Ion Collider: EIC Yellow Report, URL: https://arxiv.org/abs/2103.05419

APPROVALS:

	NAME	TITLE	DIGITAL SIGNATURE
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Approver	Elke Aschenauer	L2 Manager	Signed by: Elke Aschenauer F78CBAC47DA141D... 8/28/2024

[2] The interaction length of the calorimeter on average reduces to 6.5 λ_0 (7 before) for LFHCal and 7.5 λ_0 insert region.